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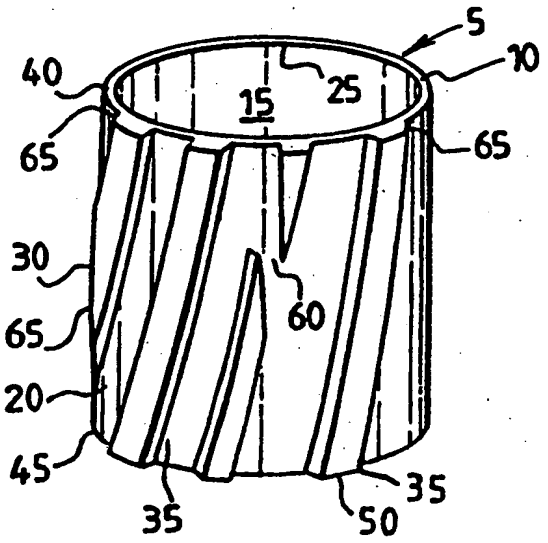
(54) Title: IMPROVEMENTS IN OR RELATING TO DOWNHOLE TOOLS

(57) Abstract

A casing centraliser (5) for centralising a casing (75) in a wellbore (85), at least a portion of the casing centraliser being plastic or ceramic, cermet or submicron grained cemented carbide. Various arrangements of raised portions (30) on the outermost surface (20) of the casing centraliser(s) (5) are described together with an arrangement of recesses (110) on the innermost surfaces (25).



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IMPROVEMENTS IN OR RELATING TO DOWNHOLE TOOLS

This invention relates to downhole tools; particularly, though not exclusively, to an improved casing centraliser; and more particularly, though not exclusively, to a casing centraliser for facilitating cementing of casing in a well.

After a well section has been drilled, it is necessary to secure a borehole of the well section by lining it with a pipe known as oilfield "casing" or "liner" - or generically "tubular".

Having installed the casing or liner within the borehole, it is necessary to make a seal in an annular space formed between the borehole and an outer surface of the pipe. This seal provides both a strengthening role - forming a composite structure of the steel pipe and the seal itself, as well as a barrier to the possible flow of fluid contained in one geological strata to another to the surface at a well head. Such a seal is usually achieved by displacing the drilling fluid in which the pipe was run, and which is thus contained in the annular space, with a cement slurry which subsequently hardens forming an impermeable barrier or sheath.

The success of cementation operations is largely determined by the displacement efficiency of the cement slurry as it displaces drilling fluid from the annulus.

This displacement efficiency is maximised by a number of factors, these include "centralisation" of the pipe (i.e. aligning the axis of rotation - longitudinal axis - of the pipe with a centre of the borehole). This keeps the pipe off the borehole wall as much as possible. In addition reciprocation of the pipe where practicable; and the creation of a degree of turbulent flow in the annulus while pumping the slurry.

From the foregoing it is clear that pipe movement forms a critical role in securing a borehole after drilling operations, both in terms of getting the pipe to the bottom of the well, where drag forces are critical factors and in maximising the displacement efficiency of the cement

slurry, in which rotational forces and centralisation are critical factors.

Boreholes are generally becoming deeper and more tortuous than ever before as Operators strive to access near field potential hydrocarbon reserves (i.e. marginal reserves close to existing infrastructure) in an effort to extend the life of their facilities. There is, therefore, a need in the industry to reduce the dynamic forces, drag and torque, required to secure the casing and liner in these boreholes thereby creating a competitive advantage over conventional equipment.

Known casing/liner centralisation and cementing accessories are made of metals such as steel, zinc and aluminium.

U.S. 5,095,981 (MIKOLAJCZYK) discloses a casing centralizer comprising a circumferentially continuous tubular metal body adapted to fit closely about a joint of casing, and a plurality of solid metal blades fixed to the body and extending parallel to the axis of the body along the outer diameter of the body in generally equally spaced apart relation, each blade having opposite ends which are tapered outwardly toward one another and a relatively wide outer surface for one another and a relatively wide outer surface for bearing against the well bore or an outer casing in which the casing is disposed, including screws extending threadedly through holes in at least certain of the blades and the body for gripping the casing so as to hold the centralizer in place.

WO 91/05093 (WEATHERFORD) discloses apparatus for use with a tubular member, which apparatus comprises: a generally cylindrical hollow body having an inner surface of substantially uniform diameter, an outer surface, a first end and a second end, and disposed on a tubular member a plurality of ribs extending from and spaced apart on said body, characterised in that the distance between at least one adjacent pair of ribs and/or the thickness of the generally cylindrical hollow body is not uniform throughout the length of the apparatus.

EP 0 671 546 A1 (DOWNHOLE PRODUCTS) discloses a casing

centraliser comprising an annular body, a substantially cylindrical bore extending longitudinally through said body, and a peripheral array of a plurality of longitudinally extending blades circumferentially distributed around said body to define a flow path between each circumferentially adjacent pair of said blades, each said flow path providing a fluid flow path between longitudinally opposite ends of said centraliser, each said blade having a radial outer edge providing a well bore-contacting surface, and said cylindrical bore through said body being a clearance fit around tubular casing intended to be centralised by said casing centraliser, the centraliser being manufactured from a material which comprises zinc and preferably a zinc alloy.

The content of the abovementioned prior art citations is incorporated herein by reference.

It is an object of one or more aspects of the present invention to obviate or mitigate problems in the prior art.

It is a further object of one or more aspects of the present invention to seek to meet the aforementioned industry need.

According to a first aspect of the present invention there is provided a casing centraliser at least a portion of at least one surface of which is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

Each material has a number of advantages over the other.

Advantageously the plastics material may be a polymer of carbon monoxide and alpha-olefins, such as ethylene.

Advantageously the material may be an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide - optionally with propylene.

Advantageously the material may be CARILON (Trade Mark) available from Shell Chemicals. CARILON (Trade Mark) is a class of semi-crystalline thermoplastic materials with an alternating olefin - carbon monoxide structure.

Alternatively the plastics material may be a nylon

resin.

Advantageously the plastics material may be an ionomer modified nylon 66 resin.

Advantageously the plastics material may be ZYTEL (Trade Mark) available from Du Pont. ZYTEL (Trade Mark) is a class of nylon resins which, includes unmodified nylon homopolymers (e.g. PA 66 and PA612) and copolymers (e.g. PA 66/6 and PA 6T/MPMDT, etc.) plus modified grades produced by the addition of heat stabilizers, lubricants, ultraviolet screens, nucleating agents, toughenerers, reinforcements, etc. The majority of resins have molecular weights suited for injection moulding and some are used in extrusion.

Alternatively the plastics material is VESCONITE (Trade Mark) available from Vesco Plastics Australia Pty Ltd.

Alternatively the material may be polytetrafluoroeth(yl)ene (PTFE).

In such case the material may be TEFLON.

The ceramic material may be, for example, zirconia, titania and/or alumina. The ceramic material may be toughened by addition of a further material, for example zirconia with the addition of alumina.

The casing centraliser may comprise a tubular body.

The tubular body may have a bore extending longitudinally therethrough.

The body may provide an outermost surface and an innermost surface.

The outermost surface may provide a plurality of raised portions.

The raised portions may be in the form of longitudinally extending blades or ribs or may alternatively be in the form of an array of nipples.

Adjacent raised portions may define a flow path therebetween such that fluid flow paths are defined between first and second ends of the tubular body.

Where the raised portions comprise longitudinal blades, such blades may be formed substantially parallel to an axis of the tubular body.

Alternatively, the blades may be formed in a longitudinal spiral/helical path on the tubular body.

Advantageously adjacent blades may at least partly longitudinally overlap on the tubular body.

Preferably adjacent blades may be located such that one end of a blade at one end of the tubular body is at substantially the same longitudinal position as an end of an adjacent blade at another end of the tubular body.

More preferably, the blades may have an upper spiral section, a middle substantially straight portion and a lower tapered portion.

Each raised portion may provide a wellbore contacting surface.

The bore through the body may be a clearance fit around a tubular casing intended to be centralised by the centraliser.

In one embodiment the outermost and/or innermost surfaces of the centraliser may be selected from a plastics material or a ceramic material, cermet or submicron grained cemented carbide, and advantageously comprise CARILON.

In such an embodiment the outermost and/or innermost surfaces may comprise a coating formed on an inner tubular body.

The inner tubular body may be made of a metallic material such as steel, zinc, zinc alloy, or preferably from aluminium or aluminium alloy.

In a further, preferred embodiment the body may be made from a material selected from a plastic material or a ceramic material, and advantageously may be CARILON.

The casing centraliser according to the first aspect of the present invention may be formed from a casting process.

Alternatively and advantageously the casing centraliser according to the first aspect of the present invention may be formed from an injection moulding process.

Advantageously the casing centraliser may be formed with the innermost surface providing at least one and preferably a plurality of spaced apart longitudinally extending tapered recesses. The recess(es) may taper from

an upper end towards a lower end of the centraliser.

According to a second aspect of the present invention there is provided a wellbore casing apparatus including a well casing and at least one casing centraliser located thereupon, wherein at least a portion of at least one surface of the centraliser is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

The well casing is preferably of a hollow tubular form.

Further the at least one centraliser may comprise a tubular body.

The at least one centraliser may be located so as to surround the casing.

The at least one centraliser may be located relative to the casing by means of a collar.

The at least one centraliser may be located relative to the casing and may be rotatable relative to the casing along a longitudinal axis thereof.

According to a third aspect of the present invention there is provided a method of cementing a well casing into a well bore, the method comprising the steps of:

providing a well casing;

providing at least one casing centraliser, the/each centraliser comprising at least a portion of at least one surface of which is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide;

locating the at least one centraliser on the casing a desired position so as to provide a casing apparatus;

placing the casing apparatus with the borehole;

pumping cement into an annular space between an exterior of the casing and the wellbore.

According to a fourth aspect of the present invention there is provided a downhole device/apparatus/tool at least a portion of at least one surface of which is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

Each material provides a number of advantages over the

others.

The downhole device/apparatus/tool may be, for example, a casing, a casing centraliser, a protector, a stabiliser, a liner/a glider, and/or a turbulating clamp, an anti-casing war device such as a non-rotating drill pipe protector or sacrificial wear bushing, a logging/wireline conveyed tool/tool string, and/or a control line clamp for the purpose of actuating downhole safety devices, gauges and/or pumps.

Advantageously the material may be a thermoplastic polymer.

Advantageously the material may be polymer of carbon monoxide and alpha-olefins, such as ethylene.

Advantageously the material may be an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide - optionally with propylene.

Advantageously the material may be CARILON (Trade Mark) available from Shell Chemicals. CARILON (Trade Mark) is a class of semi-crystalline thermoplastic materials with an alternating olefin - carbon monoxide structure.

Alternatively the material may be polytetrafluoroeth(yl)ene) (PTFE).

In such case the material may be TEFLON.

The ceramic material may be, for example, zirconia, titania and/or alumina. The ceramic material may be toughened by addition of a further material, for example zirconia with the addition of alumina.

The device may comprise a main body.

The main body may comprise or be at least partially coated with the material.

According to a fifth aspect of the present invention there is provided a casing centraliser comprising a tubular body having an outermost surface carrying a plurality of raised nipple portions.

The plurality of raised nipple portions may comprise an array of portions, adjacent portions being substantially equally spaced around the outermost surface.

According to a sixth aspect of the present invention

there is provided a casing centraliser comprising an outermost surface, the outermost surface providing a plurality of raised portions, the raised portions are in the form of longitudinally extending blades or ribs, the blades or ribs are formed in a longitudinal spiral/helical path on a tubular body wherein adjacent blades are located such that the top of a blade at a first end of the tubular body is at the same longitudinal position as the bottom of an adjacent blade at a second end of the tubular body.

Preferably the blades or fins have an upper spiral section, a middle substantially straight portion and a lower tapered portion.

According to a seventh aspect of the present invention there is provided a casing centraliser at least a portion of at least one surface of which is coloured wherein the colour identifies an outer and/or inner diameter of the casing centraliser.

According to an eight aspect of the present invention there is provided a colour coded set of casing centralisers comprising a plurality of casing centraliser, each casing centraliser has at least a portion of at least one surface coloured wherein the colour identifies an outer and/or inner diameter of the casing centraliser.

According to a ninth aspect of the present invention there is provided a casing centraliser composing a radioactive element, wherein the radioactive element is traceable to reveal the position of the casing centraliser when located in a wellbore.

One or more of the nipple portions may be substantially parallelogram or diamond shaped.

Adjacent raised nipple portions may define a flow path therebetween such that a fluid (cement) flow pth/paths are defined between first and second ends of the tubular body.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, which are:

Fig. 1 a perspective view from one side and above of a first embodiment of a casing centraliser according to the present invention;

Fig. 2 a perspective view from one side and above of a second embodiment of a casing centraliser according to the present invention;

Fig. 3 a top view of the casing centraliser of Fig. 3;

Fig. 4 a perspective view from one side and above of a third embodiment of a casing centraliser according to the present invention;

Fig. 5 a perspective view from one side and below of a fourth embodiment of a casing centraliser according to the present invention;

Fig. 6 a perspective view from one side and above of the casing centraliser of Fig. 5;

Fig. 7 a schematic side view of a wellbore having a casing apparatus including casing centralisers according to the present invention;

Fig. 8(a) and (b) a perspective view from one side and above and a view from one side respectively of the casing centraliser of Fig. 5 positioned relative to a casing;

Fig. 9 a perspective view from one side and above of a fifth embodiment of a casing centraliser according to the present invention;

Fig. 10 a perspective view from one side and above of a sixth embodiment of a casing centraliser according to the present invention;

Fig. 11 a perspective view from one side and below of the casing centraliser of Fig. 10, and

Fig. 12 a cross-sectional view of a casing centraliser and casing according to a seventh embodiment of the present invention.

Referring to Fig. 1, there is shown a first embodiment of a casing centraliser, generally designated 5, according to the present invention. At least a portion of at least one surface of the casing centraliser 5 is selected from a material advantageously providing a good tribiological performance and comprising a plastics material or a ceramic material, cermet or submicron grained carbide. In this embodiment the material is a thermoplastic polymer, particularly a polymer of carbon monoxide and alpha-

olefins, and more particularly CARILON (Trade Mark) available from Shell Chemicals, as will hereinafter be discussed in greater detail. In an alternative embodiment the material is polytetrafluoroeth(yl)ene (PTFE), and particularly TEFLON. In a further alternative embodiment the material is a ceramic material, for example selected from zirconia, titania and/or alumina perhaps toughened with titanium carbide, or alternatively a titanium based ceramic, perhaps with additions of aluminium/boron and nitrogen, or alternatively silicon nitride.

The casing centraliser 5 comprises a tubular body 10. The tubular body 10 has a bore 15 extending longitudinally therethrough. The body 10 is provided with an outermost surface 20 and an innermost surface 25. The outermost surface 20 is provided with a plurality of raised portions 30. In this embodiment the raised portions 30 are in the form of longitudinally extending blades, ribs or flutes 35.

Adjacent blades 35 define a flow path therebetween such that a fluid (concrete) flow path/paths are defined between first and second ends 40, 45 of the tubular body 10.

In this embodiment the blades 35 are formed in a longitudinal spiral path around the tubular body 10. In an alternative embodiment the blades 35 may be formed substantially equally spaced one from the other and substantially parallel to an axis of the tubular body 10.

Each blade 35 provides a wellbore contacting/bearing surface 50.

As can best be seen from Fig. 7, bore 15 through the body 10 is a clearance fit around a tubular basing 55 intended to be centralised by the centraliser 5.

In this embodiment the body 10 including blades 35 is made from a material selected from a plastics material or a ceramics material, cermet or submicron grade carbide, and particularly CARILON (Trade Mark).

In an alternative embodiment the outermost and/or innermost surfaces 20, 25 of the centraliser 5 may be selected from a plastics material or a ceramic material, cermet or submicron grained cement carbide, and

advantageously comprise CARILON. In such an embodiment the outermost and/or innermost surfaces 20,25 may comprise a coating formed on an inner tubular body. The inner tubular body may be made of a metallic material such as steel, zinc, zinc alloy, or preferably from aluminium or aluminium alloy.

CARILON (Trade Mark) is a semi-crystalline aliphatic polyketone as disclosed in Shell Chemical Literature available from their web-site bttp://www.shellchemical.com as at 10th November, 1998 and included herein by reference. According to the literature CARILLON (Trade Mark) is characterised by the following:

- Short moulding cycles and good mould definition
- Low warpage and no need for post-moulding conditioning
- Superior resilience and snapability
- Very good impact performance over a broad temperature range
- Very good chemical resistance and barrier performance
- Very good hydrolytic stability
- Good friction/wear characteristics and low noise generation

A range of CARILON (Trade mark) is used depending on the performance required and the fabrication method i.e. extrusion or injection moulding. The current range is:

- SC:2544-97 - CARILON® D26CX100 -- Advanced extrusion grade
- SC:2545-97 - CARILON® D26FX100 -- General-purpose extrusion grade
- SC:2546-97 - CARILON® D26HM100 -- General-purpose injection moulding grade
- SC:2547-97 - CARILON® D26VM100 -- High-flow injection moulding grade.
- SC:2548-97 - CARILON® DB6G3A10 -- 15% Glass-reinforced general-purpose injection moulding grade
- SC:2549-97 - CARILON® DB6GA10 -- 30% Glass-reinforced general-purpose injection moulding grade
- SC:2550-97 - CARILON® DB6F0A10 -- Flame-retarded (V-0), injection moulding grade
- SC:2551-97 - CARILON® DB6F5G40 -- Flame-retarded (V-0), 20% glass-reinforced, injection moulding grade
- SC:2552-97 - CARILON® DB6F1G30 -- Flame-retarded (V-1), tracking-resistant, 15% glass-reinforced, injection moulding grade
- SC:2533-97 - CARILON® DA6L1A10 -- Lubricated injection moulding grade
- SC:2554-97 - CARILON® DA6P2L10 -- High-performance lubricated injection moulding grade
- SC:2557-97 - CARILON® DB6G6P30 -- Lubricated, glass-reinforced, injection moulding grade

For some environments ZYTEL (Trade Mark) can be used. ZYTEL (Trade Mark) is a nylon resin available from Du Pont which can be injection moulded, and is disclosed on their web-site http://www.dupont.com as at 12th November, 1998, included herein by reference. Currently thirteen grades of ZYTEL (Trade Mark) can be used, namely:

- 408L NC0 — Ionomer modified nylon 66 resin
- 450HSL BK 152 — Olefinic/rubber modified nylon 66 resin
- 3189 NC010 — Cube blend, stiff, rubber modified nylon 66 resin
- FN718 NC010 — Flexible, grafted ionomer modified nylon 66 resin
- FN714 NC010 — Very flexible, grafted ionomer modified nylon 66 resin
- CFE4003HS BK245 — Heat Stabilized, toughened black nylon 66 resin
- CFE4004HS NC010 — Heat Stabilized, toughened nylon 66 resin
- CFE4005HS BK246 — Het Stabilized, highly toughened black nylon 66 resin
- CFE4006HS NC010 — Heat Stabilized, highly toughened nylon 66 resin

which are toughened nylons and

- ST801 NC010 — Grafted rubber modified nylon 66 resin
- ST801W NC010 — Grafted rubber modified nylon 66 resin
- ST801W BK195 — Grafted rubber modified nylon 66 resin
- ST901L NC010 — Grafted rubber modified amorphous nylon resin

which are super tough nylons.

A further alternative plastics material which is used in VESCONITE (Trade Mark). It is available from Vesco Plastics Australia Pty Ltd. VESCONITE (Trade Mark) exhibits greater hardiness, lower friction, negligible water absorption and higher chemical resistance than nylon. VESCONITE (Trade Mark) can be machined. Of better quality is VESCONITE HILUBE (Trade Mark) which can be injection moulded.

The casing centraliser 5 according to the present

invention may advantageously be formed from an injection moulding process. Alternatively the casing centraliser 5 according to the present invention may be formed from a casting process.

The casing centraliser 5 illustrated in Fig. 1 is fabricated from an injection moulding process. In order to facilitate ease of fabrication by injection moulding it should be noted that one of the blades 35 is formed with a gap 60 for provision of a moulding split-line. It is further noted that side edges 65 of each of the blades 35 of the casing centraliser 5 are substantially parallel to one another again for provision of a moulding split-line.

As mentioned hereinbefore, in this embodiment the body 10 including raised portions 30 is made from CARILON (Trade Mark). CARILON (Trade Mark) thermoplastic polymers are a category of performance polymers available from Shell Chemicals, comprising polymers of carbon monoxide and alpha-olefins, such as ethylene, having linear alternating structures known as aliphatic polyketones (PK). CARILON (Trade Mark) provides a good balance of mechanical properties, low wear, chemical/fuel resistance and efficient processing, exhibiting good hydrolythic stability and low moisture absorption. Further it provides good tribiological properties.

Referring now to Fig. 7, in use, the casing centraliser 5 forms part of a wellbore casing apparatus 70.

The wellbore casing apparatus 70 includes a well casing 75 and at least one casing centraliser 5 located thereupon. The well casing 75 is of a hollow tubular form. The at least one centraliser 5 is located so as to surround the casing 75. The at least one centraliser 5 is located relative to the casing by means of a stop collar 80, as is known in the art. In this embodiment the at least one centraliser is located relative to the casing and is rotatable relative to the casing by means of collar 80 along a longitudinal axis thereof.

In use, the well casing 75 is cemented into a well bore 85, by the following method steps of:

providing a wellbore 85;

providing a well casing 75;

providing at least one casing centraliser 5;

locating the at least one centraliser 5 on the casing 75 at a desired position so as to provide a casing apparatus 70;

placing the casing apparatus 70 within the borehole 85;

pumping cement 89 into an annular space 90 between an exterior of the casing 75 and the wellbore 85.

The cement 89 may be pumped down an inside of the well casing 75 and thence up the annular space 90 so as to remove drilling fluid from the borehole 85, as is known in the art.

In this way the centraliser(s) 5 position the casing 75 within the wellbore 90 by means of raised portions 30 - in this embodiment blades 35 - the contacting surface 50 of which abut the wellbore 90 wall where required. This suitably provides annular space 90 for cementation of the casing apparatus 70 within the wellbore 85.

Referring now to Figs 2 and 3, there is shown a second embodiment of a casing centraliser, generally designated 5a according to the present invention. Like parts of the casing centraliser 5a are identified by the same numerals as in the casing centraliser 5 but suffixed with "a".

In the centraliser 5a the outermost surface 20a is provided with a plurality of raised portions 30a in the form of an array of substantially equally spaced nipples 35a. The nipples 35a are, in this embodiment, of substantially diamond or parallelogram shape. The precise shape and dimensions of the nipples 35a may be designed to achieve a "flow by" and "bearing surface" of optimum efficiency.

Referring now to Fig. 4, there is illustrated a third embodiment of a casing centraliser, generally designated 5b according to the present invention. Like parts of the casing centraliser 5b are identified by the same numerals as in the casing centraliser 5 but suffixed with "b".

In the centraliser 5b the outermost surface 20b is provided with a plurality of raised portions 30b in the

form of an array of substantially equally spaced nipples 35b. The nipples 35b are, in this embodiment, of substantially inverted inclined teardrop shape. The precise shape and dimensions of the nipples 35b may be designed to achieve a "flow by" and "bearing surface" of optimum efficiency.

Referring now to Figs. 5, 6 and 8 there is illustrated a fourth embodiment of a casing centraliser, generally designated 5c, according to the present invention. Like parts of the casing centraliser 5c are identified by the same numerals as in the casing centraliser 5 but suffixed with "c".

In the centraliser 5c the blades/flutes 35c have an upper spiral portion 100c and a middle substantially straight portion 105c, and a lower tapered portion 106 . This blade 35c is novel in itself and provides various advantages to known blade designs.

The inner surface 25c of the centraliser 5c is further provided with a plurality of circumferentially spaced apart longitudinally extending tapered recesses 100c. In this embodiment the recesses 110c taper from the upper end 40c towards the lower end 45c. The recesses 110c facilitate ease of release of the centraliser 5c from a mould during manufacture where the centraliser 5c is made from moulding techniques such as injection moulding.

Referring now to Fig. 9 there is illustrated a fifth embodiment of a casing centraliser, generally designated 5d. Like parts of the casing centraliser 5d are identified by the same numerals as in the casing centraliser 5 but suffixed with "d".

In this embodiment the blades 35 comprise three sections. Upper and lower sections, 205d, 210d, have outer surfaces which taper from the full height of the blade 35d to the tubular body 10d on its outer surface 25d. Upper sections 205d of all blades 35d are substantially parallel. Similarly lower sections 210d of all blades 35d are substantially parallel. The centre portion 215d is substantially trapezoidal in cross-section. The centre portion 215d defines a helical path around the tubular body

10d. Five blades 35d are equally spaced around the tubular body 10d.

Referring now to Figs. 10 and 11, there is illustrated a sixth embodiment of a casing centraliser, generally designated 5e, according the present invention. Like parts of the casing centraliser 5e are identified by the same numerals as in the casing centraliser 5 but suffixed with "e". Casing centraliser 5e has an outermost surface 20e and an innermost surface 25e. Raised portions on the outermost surface 20e are identical to those of the fifth embodiment in Fig. 9, and are labelled accordingly. The innermost surface 25e has recesses as illustrated in the fourth embodiment, Fig. 5

Reference is now made to Fig. 12 of the drawings, there is shown a seventh embodiment of a casing centraliser, generally designated 5f according to the present invention. Like parts of the casing centraliser 5f are identified by the same numerals as in the casing centraliser 5 but suffixed with "f".

In the casing centraliser 5f the outermost surface 20f is provided with a recessed portion 305f. Within the recessed portion 305f is contained a plug 310f. The plug 310f which is typically made from the same material as the centraliser may be painted with a radioactive element, e.g.α-source on a outer surface. This facilitates the use of a radioactive detector for determining the position of the casing centraliser 5f within the wellbore. Additionally the signal from the radioactive element comprising the plug 310f can be used to provide a depth indicator for logging purposes.

The centraliser casings illustrated may all be coloured. This may be achieved by coating a surface of the centraliser or, preferably, dyeing the plastic or ceramic material before fabrication. The dye may comprise a nylon base and may be approximately 2% of the centraliser material and does not contain heavy metal or diraylide. The colour selected may indicate the outer or inner diameter of the casing centraliser. In a preferred embodiment the CARILLON (Trade Mark) is dyed with 3-

Carotene (available from Aldrich Chemical, Dorset, England) to give an orange coloured casing centraliser. The orange centraliser may have an inner diameter of approximately 3½ inches, to give a clearance fit on a 3½ inch O.D. casing, pipe or tubing. Similarly a casing centraliser coloured red could be sized to fit a casing with an O.D. of 2⅞ inches and a yellow casing centraliser could be sized to give a clearance fit to a casing of 4 inch O.D. Colouring the casing centraliser provides easy identification and facilitates ease in accessing quantities available at a drill site.

It will be appreciated by those skilled in the art that the embodiments of the invention hereinbefore described are given by way of example only, and are not meant to limit the scope of the invention in any way. It is noted that the term "centraliser" has been used herein; however it will be appreciated that the device also acts as a "liner glider".

In particular it should be appreciated that:

a) The use of low friction materials such as plastics, Teflon, composites and ceramics will significantly improve the effectiveness of current borehole securing operations and extend their scope by offering Operators the opportunity to run casings and liners in deeper and more tortuous wells than has hitherto been possible. This reduces the drag/frictional forces thus allowing the pipe to reach the desired depth and desired rotational speeds. These materials can be formed into devices that can be fitted externally onto the pipes prior to installation.

B) The use of low friction laminates and coatings such as plastic, Teflon, composites and ceramics will significantly enhance the performance of existing metal oilfield equipment, by reducing the drag/frictional forces thus allowing the pipe to reach the desired depth and desired rotational speeds.

C) The use of plastic, Teflon or composite material will prolong the life of wells due to the lack of galvanic corrosion associated with the use of dissimilar metals

in saline environments.

D) The use of plastic or composite makes kit lighter in weight, which makes for easier installation and means that the device will float in certain drilling fluids.

E) Design may be used in other downhole equipment to enhance efficiency, as will the use of ceramics or Teflon, e.g. stabilisers in drilling operations.

CLAIMS

1. A casing centraliser at least a portion of at least one surface of which is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

2. A casing centraliser as claimed in claim 1, wherein the plastics material is a polymer of carbon monoxide and alpha-olefins, such as ethylene.

3. A casing centraliser as claimed in claim 1 or claim 2, wherein the plastics material is an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide - optionally with propylene.

4. A casing centraliser as claimed in any one of claims 1 to 3, wherein the plastics material is selected from a class of semi-crystalline thermoplastic materials with an alternating olefin - carbon monoxide structure such as CARILON (Trade Mark).

5. A casing centraliser as claimed in claim 1, wherein the plastics material is a nylon resin.

6. A casing centraliser as claimed in claim 1 or claim 5, wherein the plastics material is an ionomer modified nylon 66 resin.

7. A casing centraliser as claimed in any one of claims 1, 5, or 6, wherein the plastics material is selected from a class of nylon resins which includes "unmodified nylon homopolymers (e.g. PA 66 and PA 612) and copolymers (e.g. PA 66/6 and PA 6T/MPMDT, etc.) such as ZYTEL (Trade Mark) plus modified grades produced by the addition of heat stabilizers, lubricants, ultraviolet screens, nucleating agents, toughenners, reinforcements, etc.

8. A casing centraliser as claimed in claim 1, wherein the plastics material is VESCONITE (Trade Mark).

9. A casing centraliser as claimed in claim 1, wherein the plastics material is polytetrafluoroeth(yl)ene (PTFE).

10. A casing centraliser as claimed in claim 9, wherein the plastics material is TEFLON.

11. A casing centraliser as claimed in claim 1, wherein the ceramic material is s zirconia, titania, alumina or combinations thereof.

12. A casing centraliser as claimed in claim 1 or claim 11, wherein the ceramic material is toughened by addition of a further material, for example zirconia with the addition of alumina.

13. A casing centraliser as claimed in any preceding claim, wherein the casing centraliser comprises a tubular body.

14. A casing centraliser as claimed in claim 13, wherein the tubular body has a bore extending longitudinally therethrough.

15. A casing centraliser as claimed in claim 13 or claim 14, wherein the body provides an outermost surface and an innermost surface.

16. A casing centraliser as claimed in claim 15, wherein the outermost surface provides a plurality of raised portions.

17. A casing centraliser as claimed in claim 16, wherein the raised portions are in the form of longitudinally extending blades or ribs.

18. A casing centraliser as claimed in claim 16, wherein the raised portions are in the form of an array of nipples.

19. A casing centraliser as claimed in any one of claims 16, 17 or 18, wherein adjacent raised portions define a flow path therebetween such that at least one fluid flow path is defined b between first and second ends of the tubular body.

20. A casing centraliser as claimed in claim 17 or claim 19, wherein at least part of the blades are formed substantially parallel to an axis of the tubular body.

21. A casing centraliser as claimed in claim 17 or claim 19, wherein the blades are formed in a longitudinal spiral/helical path on the tubular body.

22. A casing centraliser as claimed in claims 17, 19 or 21, wherein adjacent blades at least partly overlap longitudinally on the tubular body.

23. A casing centraliser as claimed in claims 17, 19, 20 or 21, wherein adjacent blades are located such that one end of a blade at one end of the tubular body is at substantially the same longitudinal position as an end of an adjacent blade another end of the tubular body.

24. A casing centraliser as claimed in claims 17 to 23, wherein the blades have an upper spiral section, a middle substantially straight portion and a lower tapered portion.

25. A casing centraliser as claimed in any one of claims 16 to 24, wherein each raised portion provides a wellbore contacting surface.

26. A casing centraliser as claimed in any one of claims

14 to 25, wherein the bore through the body is a clearance fit around a tubular casing intended to be centralised by the centraliser.

27. A casing centraliser as claimed in any one of claims 15 to 26, wherein the innermost surface comprises at least one longitudinally extending tapered recess.

28. A casing centraliser as claimed in claim 27, wherein the at least one longitudinally extending tapered recess is a plurality of longitudinally extending tapered recesses, circumferentially spaced apart.

29. A casing centraliser as claimed in claim 27 or claim 28, wherein the at least one longitudinally extending tapered recess is tapered from an upper end to a lower end.

30. A casing centraliser as claimed in any one of claims 15 to 29, wherein the outermost and/or innermost surfaces of the centraliser are/is selected from a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

31. A casing centraliser as claimed in any one of claims 15 to 30, wherein the outermost and/or innermost surfaces of the centraliser comprises CARILON (Trade Mark).

32. A casing centraliser as claimed in any one of claims 15 to 31, wherein the outermost and/or innermost surfaces comprise a coating formed on an inner tubular body.

33. A casing centraliser as claimed in claim 29, wherein the inner tubular body is made of a metallic material such as steel, zinc, or zinc alloy.

34. A casing centraliser as claimed in claim 33, wherein

the metallic material is aluminium or aluminium alloy.

35. A casing centraliser as claimed in claim 32, wherein the body is made from a material selected from a plastics material or a ceramic material.

36. A casing centraliser as claimed in claim 32, or 35, wherein the body is made from CARILON (Trade Mark).

37. A casing centraliser as claimed in any preceding claim, wherein the centraliser is formed from a casting process.

38. A casing centraliser as claimed in any one of claims 1 to 36, wherein the centraliser is formed from an injection moulding process.

39. A wellbore casing apparatus including a well casing and at least one casing centraliser located thereupon, wherein at least a portion of at least one surface of the centraliser is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

40. A wellbore casing apparatus as claimed in claim 39, wherein the wellborn casing is of a hollow tubular form.

41. A wellbore casing apparatus as claimed in claim 39 or claim 41, wherein the at least one centraliser comprises a tubular body.

42. A wellbore casing apparatus as claimed in any one of claims 39 to 41, wherein the at least one centraliser is located so as to surround the casing.

43. A wellbore casing apparatus as claimed in any one of claims 39 to 42, wherein the at least one centraliser is located relative to the casing by means of a

collar.

44. A wellbore casing apparatus as claimed in any one of claims 39 to 43, wherein the at least one centraliser is located relative to the casing and is rotatable relative to the casing along a longitudinal axis thereof.

45. A method of cementing a well casing into a wellbore, the method comprising the steps of:

providing a well casing;

providing at least one casing centraliser, at least a portion of at least one surface of the/each centraliser being selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide;

locating the at least one centraliser on the casing at a desired position so as to provide a casing apparatus;

placing the casing apparatus within the borehole;

pumping cement into an annular space between an exterior of the casing and the wellborn.

46. A downhole device/apparatus/tool at least a portion of at least one surface of which is selected from a material comprising a plastics material or a ceramic material, cermet or submicron grained cemented carbide.

47. A downhole device/apparatus/tool as claimed in claim 46, wherein the downhole device/apparatus/tool is for example, a casing, a casing centraliser, a protector, a stabiliser, a liner, a glider, and/or a turbulating clamp, an anti-casing wear device such as a non-rotating drill pipe protector or sacrificial wear bushing, a logging/wireline conveyed tool/tool string, and/or a control line clamp for the purpose of actuating downhole safety devices, gauges and/or pumps.

48. A downhole device/apparatus/tool as claimed in claim 46 or claim 47, wherein the material is a thermoplastic polymer.

49. A downhole device/apparatus/tool as claimed in any one of claims 46 to 48, wherein the material is a polymer of carbon monoxide and alpha-olefins, such as ethylene.

50. A downhole device/apparatus/tool as claimed in any one of claims 46 to 49, wherein the material is an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide optionally with propylene.

51. A downhole device/apparatus/tool as claimed in any one of claims 46 to 50, wherein the material is selected from a class of semi-crystalline thermoplastic materials with an alternating olefin - carbon monoxide structure such as CARILON (Trade Mark).

52. A downhole device/apparatus/tool as claimed in any one of claims 46 to 48, wherein the material is polytetrafluoroeth(yl)ene) (PTFE).

53. A downhole device/apparatus/tool as claimed in claim 52, wherein the material is TEFLON.

54. A downhole device/apparatus/tool as claimed in claims 46 or 47, wherein the ceramic material is zirconia, titania, alumina or combinations thereof.

55. A downhole device/apparatus/tool as claimed in any one of claims 46, 47 or 54, wherein the ceramic material is toughened by addition of a further material, for example zirconia with the addition of alumina.

56. A downhole device/apparatus/tool as claimed in any one of claims 46 to 55, wherein the device comprises a

main body.

57. A downhole device/apparatus/tool as claimed in claim 56, wherein the main body comprises or is at least partially coated with the material.

58. A casing centraliser comprising a tubular body having an outermost surface carrying a plurality of raised nipple portions.

59. A casing centraliser as claimed in claim 58, wherein the plurality of raised nipple portions comprises an array of portions, adjacent portions being substantially equally spaced around the outermost surface.

60. A casing centraliser as claimed in any one of claims 58 or 59, wherein one or more of the nipple portions is/are substantially parallelogram or diamond shaped.

61. A casing centraliser as claimed in any one of claims 58 to 60, wherein adjacent raised nipple portions define a flow path therebetween such that a fluid (cement) flow path/paths are defined between first and second ends of the tubular body.

62. A casing centraliser having an outermost surface, the outermost surface providing a plurality of raised portions, the raised portions being in the form of longitudinally extending blades or ribs, the blades or ribs being formed in a longitudinal spiral/helical path on a tubular body, wherein adjacent blades are located such that one end of a blade at a first end of the tubular body is at substantially the same longitudinal position as one end of an adjacent blade at a second end of the tubular body.

63. A casing centraliser as claimed in claim 62, wherein the blades or fins have an upper spiral section, a

middle substantially straight portion and a lower tapered portion.

64. A casing centraliser at least a portion of at least one surface of which is coloured, wherein the colour identifies an outer and/or inner diameter of the casing centraliser.

65. A colour coded set of casing centralisers, comprising a plurality of casing centralisers, each casing centraliser having at least a portion of at least one surface coloured, wherein the colour identifies an outer and/or inner diameter of the casing centraliser.

66. A casing centraliser including a radioactive portion, wherein the radioactive portion is traceable to reveal the position of the casing centraliser when located in a wellborn.

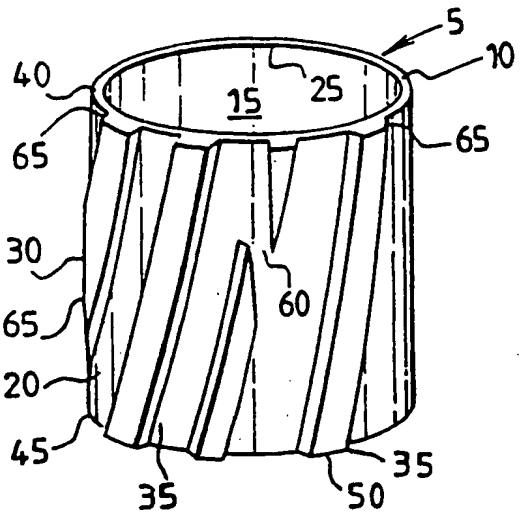

Fig. 1

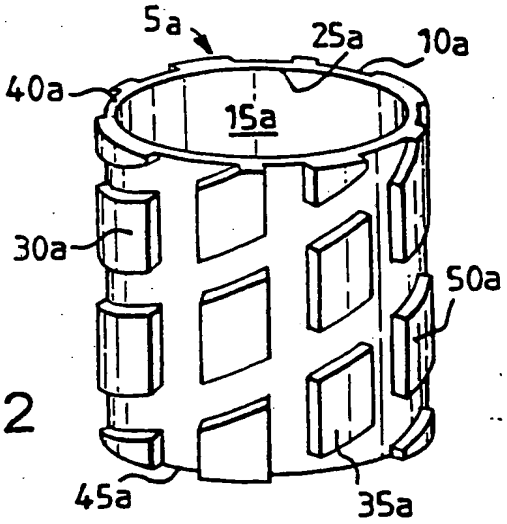

Fig. 2

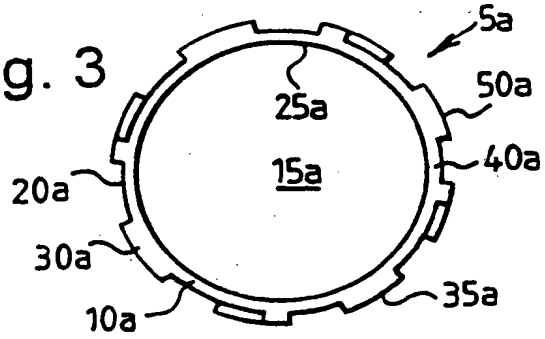

Fig. 3

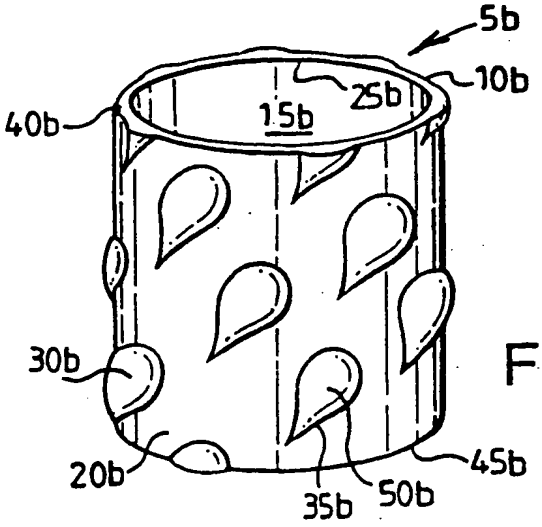

Fig. 4

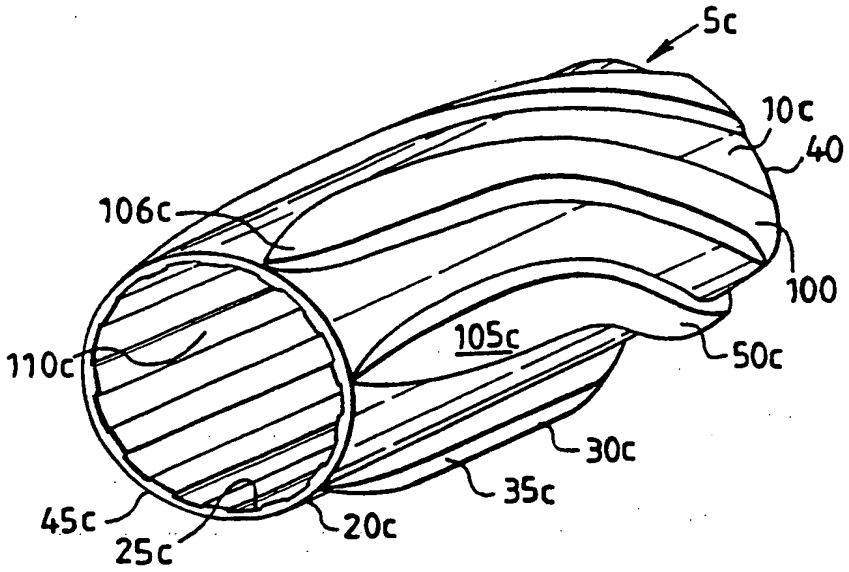

Fig. 5

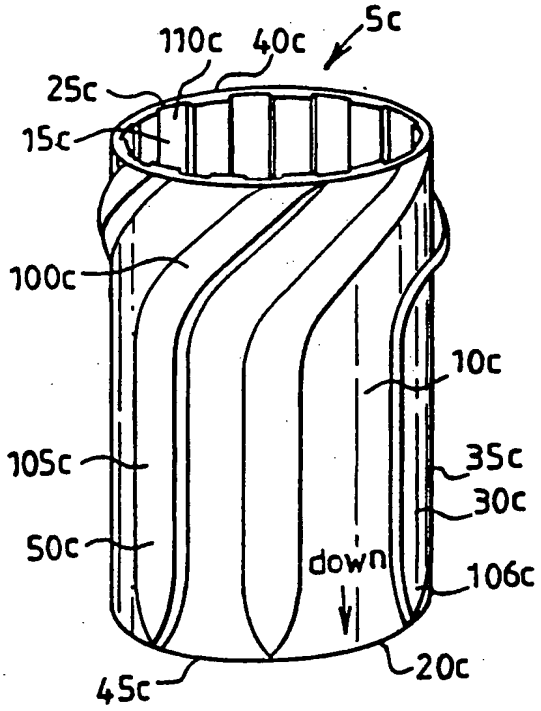

Fig. 6

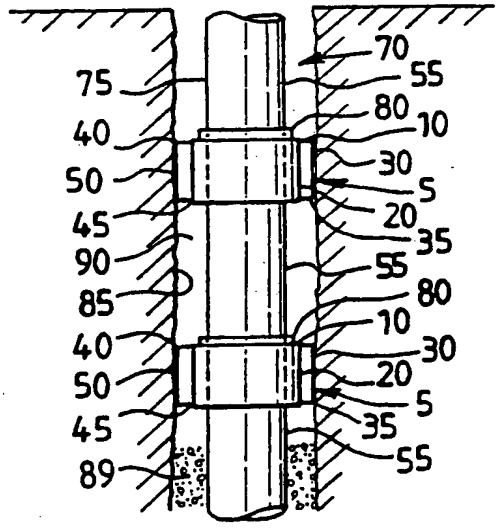

Fig. 7

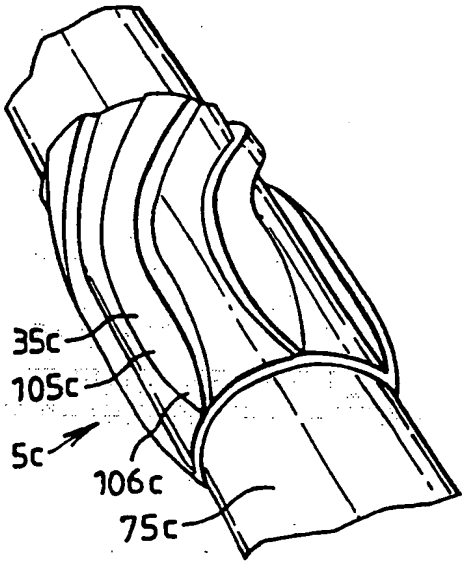

Fig. 8a

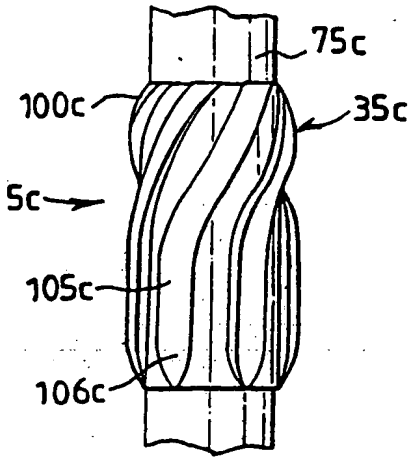

Fig. 8b

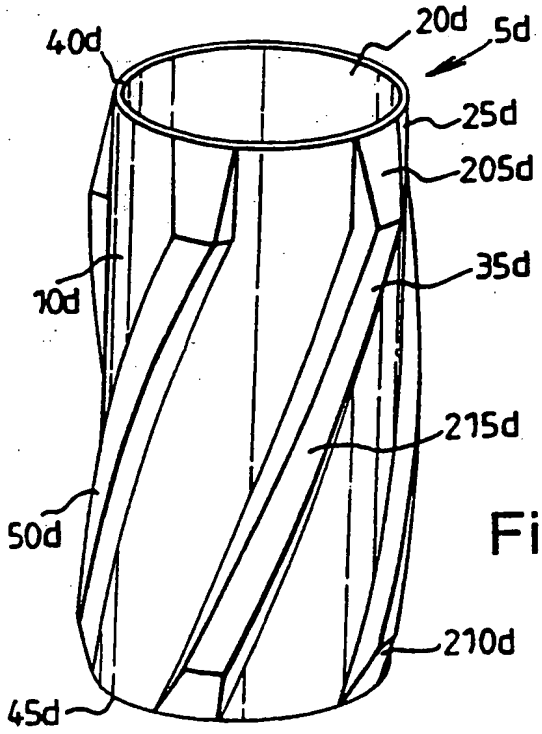

Fig. 9

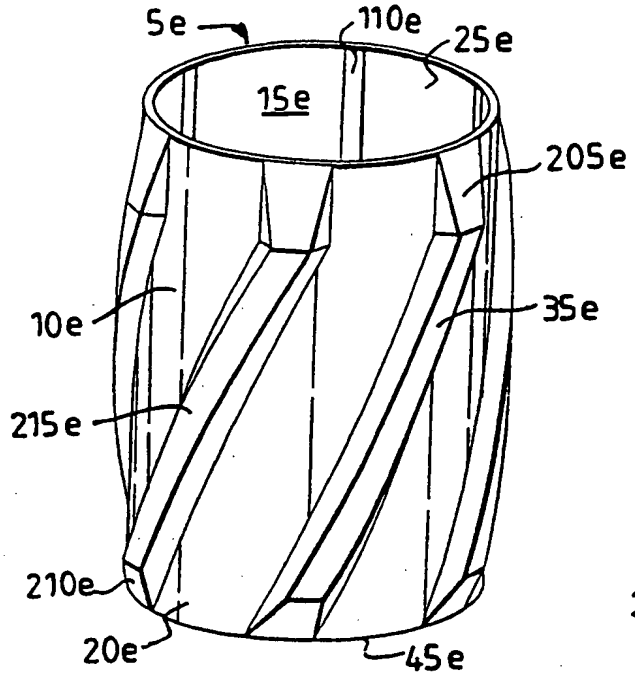

Fig. 10

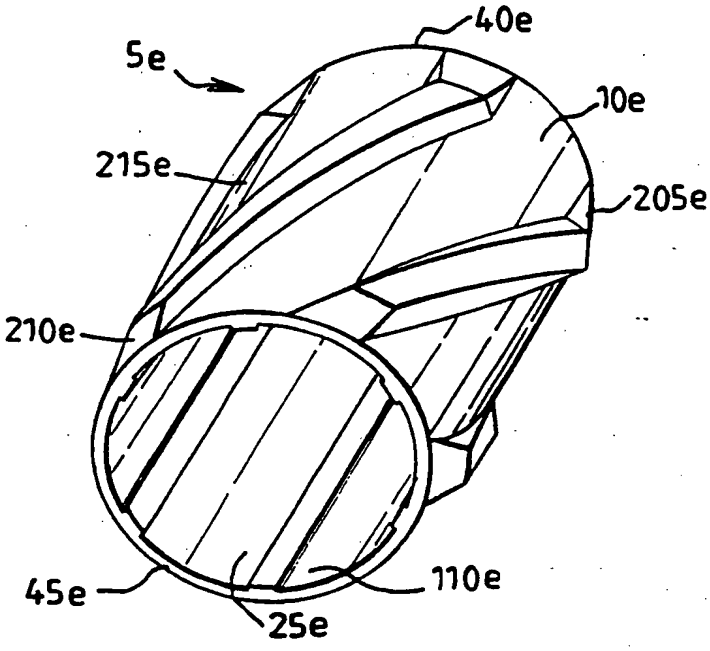

Fig. 11

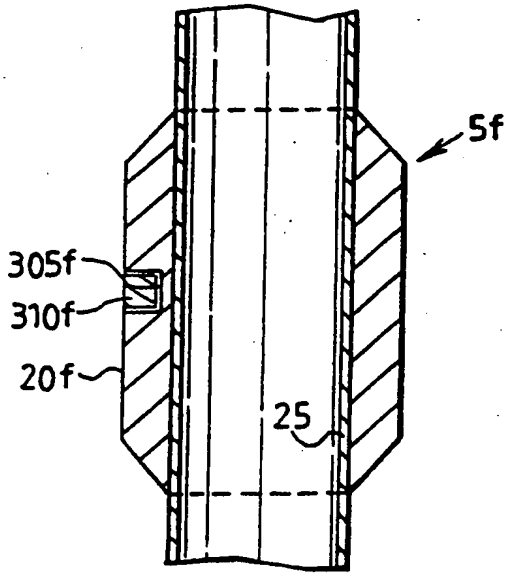

Fig. 12

The Patent Office

9

Application No: GB 9517343.1 **Examiner:** David Harrison
Claims searched: 1 to 16 **Date of search:** 3 November 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): E1F (FAC)

Int Cl (Ed.6): E21B

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US 5332049	(Tew) See Figure 5 and column 5 lines 31 to 50	1,2
X	US 4658896	(Milam) Whole document	1,2,3,4,12 13,16
X	US 4436118	(Garrett) Whole document	1,2
X	US 4434125	(Lavender *et al*) Whole document	1,2,3,16
X	US 4146060	(Garrett) Whole document	1,2,3,4,5, 14,16

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 98/03413

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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